

WHAT IS CLAIMED IS:

1. A thin film magnetic head with a write element, the write element comprising:

a first yoke portion;

5 a first pole portion projecting from a flat surface of the first yoke portion at a medium-facing surface side and having a reduced width at its upper end;

a gap film;

10 a second pole portion facing the upper end of the first pole portion, having the same width as the upper end of the first pole portion, with the gap film interposed between the second pole portion and the upper end of the first pole portion;

15 a second yoke portion continuous with the second pole portion at the medium-facing surface side and connected to the first yoke portion by a back gap portion that is recessed in the thin film magnetic head from the medium-facing surface; and

a coil surrounding in a spiral form the back gap portion on the flat surface of the first yoke portion; wherein:

20 the first pole portion includes a magnetic film adjacent to the gap film, and the magnetic film is etched at both sides in width direction so as to have a narrowed portion having substantially the same width as the second pole portion, and a base portion connected to the narrowed portion and increasing in thickness toward the narrowed portion.

2. The thin film magnetic head of claim 1, wherein:

the coil comprises a first coil and a second coil;

the first and second coils surround in a spiral form the back gap portion on a first insulating film formed on the surface of the first yoke portion, and one of the first and second coils is fitted into the space between coil turns of the other, insulated from the coil turns of the other by a second insulating film, and the first and second coils are connected to each other so as to generate magnetic flux in the same direction.

3. The thin film magnetic head of claim 1, wherein:

the coil has a space between coil turns which is filled up with an organic insulating resin;

the coil and the organic insulating resin are covered with a third insulating film of an inorganic insulating material;

the third insulating film has a flattened surface;

the first pole portion comprises a first pole piece, a second pole piece and a third pole piece;

the first pole piece is formed of an end of the first yoke portion;

the second pole piece has one surface adjacent to the first pole piece;

the third pole piece has one surface adjacent to the other surface of the second pole piece;

the other surface of the second pole piece is flattened to the same level as the flattened surface of the third insulating film;

the other surface of the third pole piece is flattened to the same level as a surface of a fourth insulating film deposited on the flattened surface of the third insulating film; and

5 the gap film is on the flattened surfaces of the third pole piece and the fourth insulating film.

4. The thin film magnetic head of claim 1, further comprising a read element, wherein:

10 the read element comprises a giant magnetoresistance effect element.

5. The thin film magnetic head of claim 4, wherein:

15 the giant magnetoresistance effect element comprises one of a spin valve film and a ferromagnetic tunnel junction.

6. A magnetic recording/reproducing apparatus comprising a thin film magnetic head and a magnetic recording medium, wherein:

the thin film magnetic head comprises a write element, the write element comprising:

20 a first yoke portion;

a first pole portion projecting from a flat surface of the first yoke portion at a medium-facing surface side and having a reduced width at its upper end;

a gap film;

a second pole portion facing the upper end of the first pole portion, having the same width as the upper end of the first pole portion, with the gap film interposed between the second pole portion and the upper end of the first pole portion;

5 a second yoke portion continuous with the second pole portion at the medium-facing surface side and connected to the first yoke portion by a back gap portion that is recessed in the thin film magnetic head from the medium-facing surface; and

a coil surrounding in a spiral form the back gap portion on  
10 the flat surface of the first yoke portion; wherein:

the first pole portion includes a magnetic film adjacent to the gap film, and the magnetic film is etched at both sides in width direction so as to have a narrowed portion having substantially the same width as the second pole portion, and a base portion connected to the  
15 narrowed portion and increasing in thickness toward the narrowed portion; and

the magnetic recording medium performs magnetic recording/reproducing operations in cooperation with the thin film magnetic head.

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7. The magnetic recording/reproducing apparatus of claim 6, wherein:

the coil comprises a first coil and a second coil;

the first and second coils surround in a spiral form the back gap

portion on a first insulating film formed on the flat surface of the first yoke portion, and one of the first and second coils is fitted into the space between coil turns of the other, insulated from the coil turns of the other by a second insulating film, and the first and second coils are connected to  
5 each other so as to generate magnetic flux in the same direction.

8. The magnetic recording/reproducing apparatus of claim 6,  
wherein:

the first pole portion comprises a first pole piece, a second pole  
10 piece, a third pole piece and a fourth pole piece;

the first pole piece is formed of an end of the first yoke portion;

the second pole piece has one surface adjacent to the first pole  
piece;

the third pole piece has one surface adjacent to the other surface of  
15 the second pole piece; and

the fourth pole piece has one surface adjacent to the other surface of  
the third pole piece and the other surface adjacent to the gap film.

9. The magnetic recording/reproducing apparatus of claim 6,  
20 wherein:

the coil has a space between coil turns which is filled up with an  
organic insulating resin;

the coil and the organic insulating resin are covered with a third  
insulating film of an inorganic insulating material;

the third insulating film has a flattened surface;

the first pole portion comprises a first pole piece, a second pole piece and a third pole piece;

the first pole piece is formed of an end of the first yoke portion;

5 the second pole piece has one surface adjacent to the first pole piece;

the third pole piece has one surface adjacent to the other surface of the second pole piece;

10 the other surface of the second pole piece is flattened to the same level as the flattened surface of the third insulating film;

the other surface of the third pole piece is flattened to the same level as a surface of a fourth insulating film deposited on the flattened surface of the third insulating film; and

15 the gap film is on the flattened surfaces of the third pole piece and the fourth insulating film.

10. The magnetic recording/reproducing apparatus of claim 6, further comprising a read element, wherein:

20 the read element comprises a giant magnetoresistance effect element.

11. The magnetic recording/reproducing apparatus of claim 10, wherein:

the giant magnetoresistance effect element comprises one of a spin

valve film and a ferromagnetic tunnel junction.

12. A method for manufacturing a thin film magnetic head with a write element, the write element comprising:

5 a first yoke portion;

a first pole portion projecting from a flat surface of the first yoke portion at a medium-facing surface side and having a reduced width at its upper end;

a gap film;

10 a second pole portion facing the upper end of the first pole portion, having the same width as the upper end of the first pole portion, with the gap film interposed between the second pole portion and the upper end of the first pole portion;

15 a second yoke portion continuous with the second pole portion at the medium-facing surface side and connected to the first yoke portion by a back gap portion that is recessed in the thin film magnetic head from the medium-facing surface; and

a coil surrounding in a spiral form the back gap portion on the flat surface of the first yoke portion; wherein:

20 the first pole portion includes a magnetic film adjacent to the gap film, and the magnetic film is etched at both sides in width direction so as to have a narrowed portion having substantially the same width as the second pole portion, and a base portion connected to the narrowed portion and increasing in thickness toward the narrowed portion;

the manufacturing method comprising the steps of:

forming in an uniform thickness a film that is to form the second yoke portion;

covering the second yoke portion with a resist mask that has an opening where the second pole portion is to be formed;

etch-backing the resist mask so as to expose a part of the second yoke portion; and

etching through the opening a part of the magnetic film and/or a part of the gap film that are in the opening.

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13. The manufacturing method of claim 12, wherein the second yoke portion comprises a second magnetic film and a third magnetic film, the manufacturing method further comprising the steps of:

forming the second magnetic film in an uniform thickness adjacent to the gap film;

forming the third magnetic film on the second magnetic film; and forming the resist mask on the third magnetic film.

14. The manufacturing method of claim 13, further comprising the step of:

etching the second magnetic film by using the third magnetic film as a mask after forming the third magnetic film and before forming the resist mask.



15. The manufacturing method of claim 13, further comprising the steps of:

removing the resist mask after etching through the opening a part of the magnetic film and/or a part of the gap film that are in the opening; and

5 etching the second magnetic film by using the third magnetic film as a mask after removing the resist mask.

16. The manufacturing method of claim 12, wherein the process for etch-backing the resist mask comprises a dry-etching process with a  
10 plasma containing O<sub>2</sub>.

17. The manufacturing method of claim 12, wherein the process for etch-backing the resist mask comprises a dry-etching process with one of halogen-based plasma and chlorofluorocarbon-based plasma.  
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18. The manufacturing method of claim 12, wherein the process for etch-backing the resist mask comprises an isotropic dry-etching process.

20 19. The manufacturing method of claim 12, wherein the process for etch-backing the resist mask comprises an anisotropic dry-etching process.

20. The manufacturing method of claim 12, wherein a magnetic

film that is one of magnetic films forming the first pole portion and is adjacent to the gap film, comprises a magnetic material containing Co and Fe.

5           21.     The manufacturing method of claim 12, wherein a magnetic film that is one of magnetic films forming the first pole portion and is adjacent to the gap film, comprises one of CoFe and CoFeN.

10           22.     The manufacturing method of claim 12, wherein a magnetic film that is one of magnetic films forming the first pole portion and is adjacent to the gap film, is a sputtering film comprising one of FeN, CoFe and CoFeN.

15           23.     The manufacturing method of claim 12, wherein the resist mask has a wall of the opening perpendicular to the surface of the magnetic film.